Case Study: Contactless Substrate Measurement Machine

Client: Eminox

NI Products Used: National Instruments LabVIEW, Micro Epsilon IDL-1700 Lasers x2, SMC Electronic Actuators, National Instruments PCI-6512 DIO card.

Application Area: Automotive.

Key Benefits:

- Increased accuracy and speed – the use of Pi Tape increased accuracy and speed compared to manual measurement methods.
- Reduced risk – automatic results automatically added to client database reduced time and human error.
- Rugged and intuitive touch screen display – has reduced training time significantly for operators.
- Engineering modes – improves research and development through measurement of new and prototype products.

The Challenge

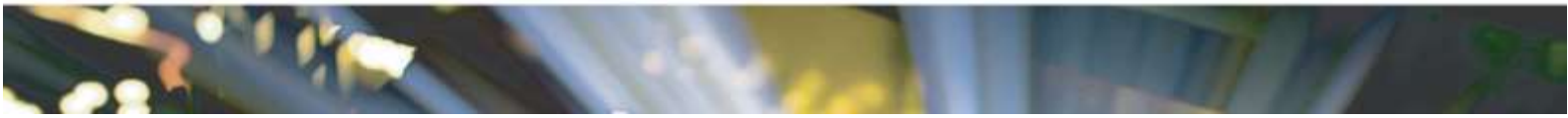
To create a substrate measurement system for Eminox Limited to accurately and reliably measure the height and diameter of their substrate products to an accuracy of 0.1mm or better. The end solution not only had to keep up with production but also handle a large variance in the size of the product in question.

Our Approach

Eminox provided us with design specifications of the machine and asked us to write the software which would get the mechanics of the machine functioning to their requirements.

We worked closely with Eminox to understand their requirements and the reasons behind developing the system. We carried out feasibility tests to ensure that the proposed solution would meet the requirements of the project, and that software and hardware would work together to solve the problem. Once these were complete, we set to work on developing the software.

The mechanical build was provided by a third party who we worked in parallel with throughout the project while we wrote the software. We worked closely with Micro-Epsilon to ensure that the lasers we selected to carry out the measurements would meet the requirements set out in the specification. We tested the machine regularly with known samples to ensure the results it was producing were accurate.



The Solution

The biggest aspect of this application was the actual measurement of the substrate product. This needed to be accurate to 0.1mm. To achieve this, we selected Micro Epsilon compact laser sensors, specifically the optoNCDT 1700 series.

As well as meeting the accuracy requirements the lasers also have some unique built in features such as their Real-Time Surface Compensation (RTSC) feature. This RTSC feature allowed the laser to get an accurate reading despite the hollow surface of the substrate. The lasers also integrate with the LabVIEW software environment.

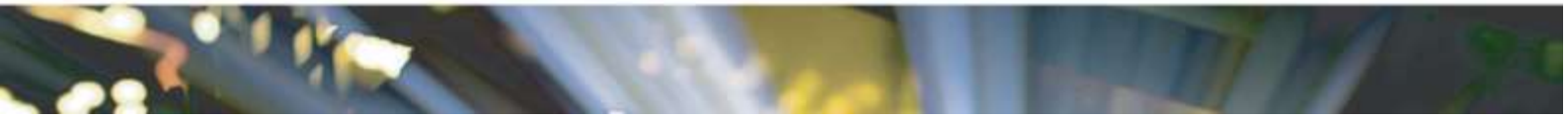
To measure the diameter of the substrate, a laser is positioned in a static place then the substrate is rotated at 30RPM. An encoder is used to trigger the laser measurements to ensure that we capture the exact number of data points for an entire revolution. The product height is more straightforward as a second laser is brought into range of the product. This takes the diameter data from the first laser with the measurement taken approximately 10mm for the outer edge. The average height is then calculated for one revolution.

The machine also had to support a large range of products from 140mm to 300mm in diameter and 100mm to 400mm in height. In order to get the measurement accuracy required the laser must have a measurement range of 100mm.

This did not cause an issue for the diameter measurement as the machine effectively measures the radius of the product which has a range of 80mm. However, the height range required was 300mm. As a result, the height laser is fitted to a pair of SMC Electronic actuators which move the lasers into place. SMC actuators were selected due to their accuracy and repeatability of positioning which is critical for the software to calculate an accurate value. The actuator is controlled via a National Instruments DIO card.

The machine was designed to save the operator valuable seconds so the entire delivery process was scrutinized to identify where time could be saved so that the production line wasn't affected.

Firstly, the software was designed to be quick, responsive and easy to use. All the product information is extracted from the Eminox central database from a barcode scanned in by the operator. The original process required the operator to manually enter data into the machine, which was time consuming and left room for error. Automating this process eliminated error completely and sped up the process.



The second stage was to rethink the user interface of the machine. The controls were replaced with a resistive touchscreen panel that requires a single button push to start the test process. A resistive touchscreen was selected as it allowed the operator to wear standard safety gloves and still operate the machine and configure the settings. The screen also needed to provide valuable information throughout the process, so rugged hardware and a good user interface would ensure that it would survive in a workshop environment.

Finally, previous machines have had the user interface accessible via a door, so to save valuable seconds a curtain was fitted instead, allowing the machine to remain safe but to increase speed of accessibility.
The application was developed in LabVIEW due to LabVIEW's ability to create easy to use industrial user interfaces and built in processing and data analysis features. By leveraging these analysis functions, Austin Consultants were able to ensure accurate and repeatable measurements. Not only did this allow us calculate the product diameter, but it also allowed us to compensate for the product not being totally central to the machine. This again saved time, as the operator wasn't required to spend valuable seconds aligning the product on the turntable.

As well as the production mode, the software also offers verification and calibration modes and off line measurements meaning that prototyping research and development products could be tested without the system writing this data to the main production database.